CHAPTER 4

Conservation priority-setting at a regional scale: a case study based on South African terrestrial mammals

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Abstract

Species' threat assessments are an essential part of regional conservation interventions. In the current study, Regional Priority Scores (RPS) were computed for 221 South African terrestrial mammals using more readily available data. These data included vulnerability (IUCN Red List assessments and regional occupancy), irreplaceability (relative endemism and taxonomic distinctiveness), and measures of threat (relative body mass and human density), and were subjected to two conservation priority assessment techniques. The RPS scores obtained from two RPS techniques differed significantly, resulting in a broad range of mammals being recognised as of conservation importance. Despite this variance, 13 mammal species were consistently emphasised to be of high conservation priority across both techniques. The top 22 species from each technique included 12 of the 2004 regional IUCN Red List threatened mammals. The two RPS techniques may represent a simplified approach for determining regional conservation priorities for taxa under various region-specific conditions.

Keywords: Regional conservation prioritisation, vulnerability, threat assessment, terrestrial mammals, South Africa

Introduction

Halting the present spate of species extinctions requires the identification and subsequent conservation of threatened species and their habitats. At a practical level, this requires incorporating threat assessments into regional conservation interventions (Master 1991; Mace 1995), which is usually based on prioritisation of areas or taxa. Due to limited resources for conservation actions, it is important to emphasise and prioritise taxa that have been identified as of importance for the conservation of biodiversity (Freitag & van Jaarsveld 1997).

However, setting conservation priorities is difficult (Harris et al. 2000) because prioritisation systems vary greatly, not only with reference to factors that are deemed important to include, but also how these factors are scored, weighted, or incorporated (Mehlman et al. 2004). In general, species conservation prioritisation traditionally focus on species that are highly vulnerable, including predictors of species extinction risk, such as population sizes and trends (Master 1991; Freitag & van Jaarsveld 1997; Dunn et al. 1999; Burgman 2002, Mehlman et al. 2004). Vulnerability and rarity information on factors that predispose species to high levels of threat or some level of extinction (Gaston, 1994; Gaston and Blackburn, 1997; Kunin and Gaston, 1997; Purvis et al., 2000; Manne and Pimm, 2001) have to date dominated conservation prioritisation exercises.

One such measure, the World Conservation Union (IUCN) Red Lists (IUCN, 1994; 2001) is probably the most widely used assessment method to identify species at the risk of extinction. The Red List categories provide a relatively simple and widely used method for identifying species under higher risk of extinction, an approach that can lead to appropriate conservation measures designed to protect such species. These Red List categories of "threat" are based on considerable ecological knowledge defined by strict sets of criteria, supported by decision rules derived from thresholds of parameters such as distributional ranges, population sizes, and life histories (IUCN 2001; Lamoreux et al. 2003).

When assessing the conservation status of a taxon against the IUCN Red List criteria, these threshold parameters are tested against the criteria, working downward through threat categories that range from Critically Endangered (CR), through Endangered (EN), to Vulnerable (VU). For example, if it is established that the taxon partly does not meet the necessary criteria to be categorized as VU, then Near Threatened (NT) may be applied. A taxon that has been evaluated and meets none of the criteria is listed as a taxon of Least Concern (LC), while an evaluated taxon that has insufficient data to test against the criteria is designated Data Deficient (DD) (IUCN 2001)

Subsequently, it is generally accepted that if a taxon is listed as threatened on the Red List (CR, EN or VU), it can be regarded as of higher conservation concern because it is considered to be more prone to extinction in the near future. Consequently, the IUCN Red List assessments and measures of rarity (relative occupancy) can function as a proxy with regard to vulnerability to extinction, and are therefore, used in the current study to express 'vulnerability'. However it is important to note that the measure of vulnerability to extinction is most often not uniform across a taxon's distribution range, but refers to the general trends of the population(s) under consideration. Often the different populations within the area under consideration respond differently to a variety of factors, and do not have a uniform threat of going extinct.

Previous studies have identified a variety of factors that are important when attempting to assess the conservation value or 'irreplaceability', and not just the vulnerability of species (Pressey et al. 1993; Williams &. Araújo 2002; Noss et al. 2002; Knapp et al. 2003). Irreplaceability as used here is a conservation value that is used as a measure of how a taxon contributes to the overall biodiversity within a specific region of interest (Pressey et al. 1993; Noss et al. 2002). Factors such as endemism (Myers et al. 2000; Williams &. Araújo 2002; Mace et al. 2003), as well as systematic significance (taxonomic and phylogenetic distinctiveness; Millsap et al. 1990; Vane-Wright et al. 1991; Posadas et al. 2001; Keith et al. 2005)) have also been high-lighted as useful surrogate measures for assessing conservation priority.

Southern African mammals are characterised by a large proportion of non-endemic widely distributed taxa (Coe & Skinner 1993), and yet 36 mammal species are classified as endemic to South Africa (Friedmann & Daly 2004). Endemic taxa are often considered to be of national conservation importance (Rebelo & Tansley 1993). The level of endemism of a taxon to a specific region usually refers to the taxon's dependence on the region conservation actions for survival (Freitag & van Jaarsveld 1997). These species are solely reliant on South Africa's conservation actions to prevent their possible extinction. Similarly, phylogenetically distinct taxa are usually deemed to be of a higher conservation value than with close genetic relatives (Vane-Wright et al. 1991; Heard & Mooers 2000; Polasky et al. 2001). Phylogenetic analyses have allowed the ranking of species according to their degrees of phylogenetic diversity, therefore, high-lighting the evolutionary history and genetic diversity of unique taxa (Freitag & van Jaarsveld 1997; Virolainen et al. 1999; Rodrigues & Gaston 2002).

Recent reviews have high-lighted that the inclusion of explicit criteria of human threats to taxa may be relevant for conservation prioritisation and conservation planning (Master 1991; Harcourt & Parks 2003; Pressey et al. 2003; van Rensburg et al. 2004). Mills et al. (2001) in their assessment of geographic priorities for terrestrial carnivores in Africa, incorporated body size as a potential estimator for human conflict in their analysis. The rationale behind the inclusion of body size was that large-bodied species are more likely to be negatively influenced by human populations (Entwistle & Stephenson 2000; Mills et al. 2001, Harcourt & Parks 2003). Secondly, a measure of human population density throughout a taxon's range has been considered to be a good indicator of human threat, more specifically to mammals at a global scale (Ceballos & Ehrlich 2002; Harcourt & Parks 2003). Both body size and human population density are deemed relevant proxies of human threat, and are consequently, included in the our priority setting analysis in the present study in order to gain an insight into current threats to South African mammals.

To this end, the current study relies on three key concepts, namely, vulnerability, irreplaceability and threat (Pressey et al. 1993; Noss et al. 2002, Harcourt & Parks 2003) that are included into the regional priority setting exercise for South African mammals.

Freitag and van Jaarsveld (1997) proposed a qualitative taxon-specific technique for assigning regional conservation priorities. The technique evaluates the regional conservation importance of taxa, assigns a Regional Priority Score (RPS) to each taxon, and was used to evaluate the conservation priority for mammals in the former Transvaal Province, South Africa (Freitag & van Jaarsveld 1997). The RPS provides a relational approach where the conservation importance of taxa is derived with reference to measures of rarity, vulnerability, and irreplaceability (Mills et al. 2001). In essence, the RPS adds value to the traditional risk assessment of the IUCN, but incorporates additional measures of the taxon's value and threat.

Consequently, the aim of the present study is threefold. First, we attempt to prioritise South African mammals with reference to measures of vulnerability, irreplaceability, and threat. Second, apart from the traditional RPS components (Freitag & van Jaarsveld 1997), we also attempt to assess the effect of the inclusion of body mass and a human density index, as additional measures of threat. Third, in order to facilitate and improve regional conservation practice, we attempt to assess the interaction between factors that may contribute to the level of threat experienced by species. To this end, we evaluate the relationships between the six RPS components included in the current regional conservation priority assessment, namely relative vulnerability (RV), relative occupancy (RO), relative endemism (RE), and taxonomic distinctiveness (RTD), relative body mass (RBM) and relative human density (RHD) (Freitag & van Jaarsveld 1997; Mills et al. 2001). Apart from contributing to our current understanding of the conservation importance/priority of South Africa terrestrial mammals, this study also attempts to assess the value of various conservation assessment tools for prioritising conservation actions and in formulating appropriate management decisions at a regional scale.

Materials and Methods

The study is based on the extant mammals of South Africa and the taxonomic treatments of Wilson and Reeder (1993) and augmented by that of Taylor (2000) for the Order Chiroptera and conforms to that used by the recent regional Red List (Friedmann & Daly 2004). For taxa with taxonomic discrepancies between these authorities, taxon specialists working on the specific problematic groups were consulted (see Friedmann & Daly 2004). The final species list, excluding subspecies and sub-populations was matched with presence data obtained from distributional records (Freitag & van Jaarsveld 1995; Keith 2004). Several taxa were excluded from the current study because no relevant distribution data were available. All subsequent distribution data were generalised to a common resolution at the quarter degree square level (QDS) representing an area of 25 x 25 km or $625km^2$) (Freitag & van Jaarsveld 1995) prior to the computation of regional priority scores.

RPS Components

Six different components were used to compute regional conservation priority scores for South African terrestrial mammals. These included the four components, described by Freitag & van Jaarsveld (1997) as well as two additional components. These components were groups into three subsets that were considered to represent measures of vulnerability, irreplaceability, and threat and were calculated as follows:

Vulnerability components

(a) *Relative vulnerability (RV)* - The regional IUCN Red Data List assessment of the regional Conservation Assessment and Management Plan (CAMP) for South African mammals (Friedmann & Daly 2004) was used to score the vulnerability categories as follows::

1.0: Critically Endangered (CR);

0.80: Endangered (EN);

0.70: Vulnerable (VU);

0.56: Near Threatened (NT);

0.42: Data Deficient (DD); and

0.00: Least Concern (LC).

(b) *Relative Occupancy (RO)* – calculated based on presence data from museum distributional records (Freitag & van Jaarsveld, 1995) as follows:

$$\text{RO} = \frac{1}{\text{No. of quarter degree squares (QDS) occupied in South Africa}}$$

Irreplaceability components

(c) *Relative Endemism (RE)* – (modified from Freitag and van Jaarsveld (1997). The extent of occurrence, obtained from various sources (Haltenorth and Diller 1980; Skinner and Smithers 1990; Mills and Hes 1997; Boitani et al. 1999; Kingdon, 2001) was categorised as follows:

1.0: Endemic to South Africa only;

0.8: 75-99% distribution in South Africa;

0.6: 50-74% distribution in South Africa;

0.4: 25-49% distribution in South Africa; and

0.2: 0-24% distribution in South Africa.

(d) *Relative Taxonomic Distinctiveness (RTD)* - calculated following the method of Freitag and van Jaarsveld (1997) as follows:

$$\text{RTD} = \frac{1}{\sqrt{\text{No. of regionally represented families x genera x species}}}$$

Threat components

(e) Relative Body Mass (RBM): Based on average body weights (in grams) for each species as obtained from Dorst & Dandelot (1972), Haltenorth & Diller (1980), and Skinner & Smithers (1990), and was computed as:

$$\text{RBM} = \frac{\log(\text{body mass (g)})}{\log(\text{BM}_{max})}$$

Body mass was log-transformed and divided by the transformed maximum South African terrestrial mammal mass (BM_{max} = African elephant, *Loxodonta Africana* value of 14.74). RBM was incorporated in the current assessment as a potential surrogate measure of human conflict following Mills et al. (2001).

(f) *Relative Human Density (RHD)* - Included as a measure of potential human interaction or "threat" based on the rationale that the higher the human density within a taxon's distributional range, the higher the level of interaction and threat to the taxon. Average human population per QDS was derived from magisterial human population data (Central Statistical Service 1998). Human density values for each taxon were calculated as follows:

$$\text{Human Density (HD)} = \frac{\sum \text{(Averaged human density across a taxon's distribution (QDS))}}{\text{No. of QDS the species occur in}}$$

In order to obtain a relative human density value for each taxon across its known distribution (in QDS), relative human density per km^2 was calculated and standardised by dividing the relative human density of a taxon by the taxon scoring the highest human density value (HD_{max}):

$$\text{RHD} = \frac{\text{HD}}{\text{HD}_{max}}$$

The large-eared free-tailed bat (*Otomops martiensseni*) scored the highest HD value among all mammals considered, with most of its QDS distribution falling within the Durban metropolitan and surrounding area, which has an average HD value of 256 people/km^2. This HD value was treated as an outlier value (2.12) and was converted to 1.00 and not used for the HD_{max} value. Instead, the second highest HD value (178 people/km^2) obtained for the Juliana's golden mole (*Neamblysomus julianae*) was used instead as HD_{max}.

Regional Priority Scoring

Two different RPS techniques for determining the relative conservation importance of South African terrestrial mammals were evaluated. The first approach (RPS_{01}) applies the RPS technique proposed by Freitag and van Jaarsveld (1997) to a national scale assessment. This method employs four components, namely, relative vulnerability (RV), relative occupancy (RO), relative endemism (RE), and taxonomic distinctiveness (RTD), subsequently ranks taxa in order of their conservation importance and is computed as follows:

$$RPS_{01} = \frac{RV + RO + RE + RTD}{4}$$

The second conservation assessment technique (RPS_{02}) was essentially based on the RPS_{01} structure, but included relative body mass (RBM) and relative human density (RHD) components, the latter two incorporated as indices of potential 'human impact' and was calculated as follows:

$$RPS_{02} = \frac{RV + RO + RE + RTD + RBM + RHD}{6}$$

Species with the top 10% RPS scores were deemed to be of the highest conservation priority for each of the two regional RPS techniques.

Statistical analyses:

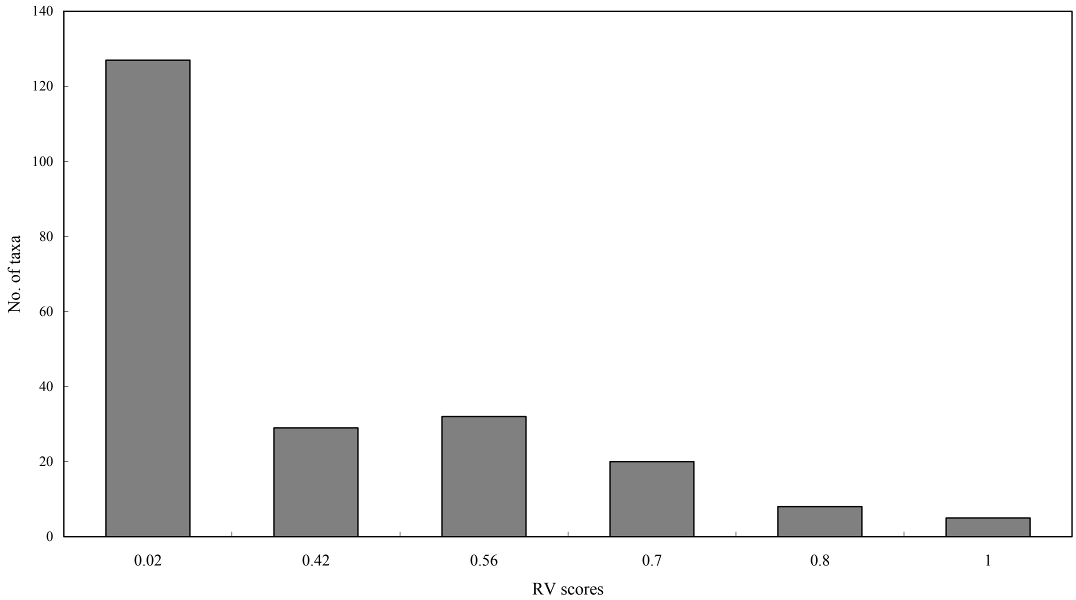
Mann Whitney *U*, Kruskal-Wallis Analysis of Variance (ANOVA) by Ranks, Wilcoxon Matched Pair tests and Spearman's *R* correlation analysis (Sokal and Rohlf 1981; Zar, 1996) were used to test for statistically significant differences and correlations between the six components. All statistical analyses were executed using Microsoft® Excel 2000 and STATISTICA version 6 (StatSoft Inc. 2001).

Results and Discussion

Two hundred and twenty one terrestrial mammal species in 13 orders and 38 families for which data were available, were used to assess the two RPS techniques and their respective regional priority scores.

Table 1. Spearman Rank order correlations of pairs of Regional Priority Score components (r-values included): Relative Vulnerability (RV), Relative Occupancy (RO), Relative Taxonomic Distinctiveness (RTD), Relative Endemism (RE), Relative Body Mass (RBM) and Relative Human Density (RHD). All values in bold indicate statistical significance of P < 0.05. Non-bold values denote no statistically significant values.

	RV	**R 0**	**RE**	**RTD**	**RHD**
RO	**0.5**	-			
RE	-0.01	0.04	-		
RTD	-0.04	**-0.15**	**-0.25**	-	
RHD	**0.19**	**0.14**	**-0.19**	-0.08	-
RBM	**-0.26**	**-0.32**	**-0.25**	**0.51**	-0.11



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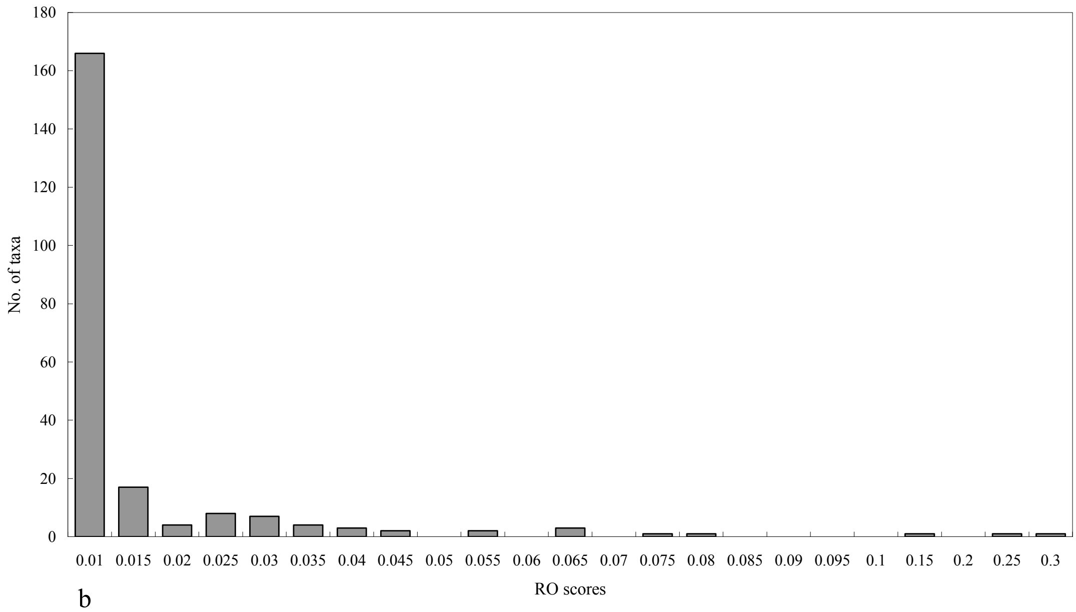

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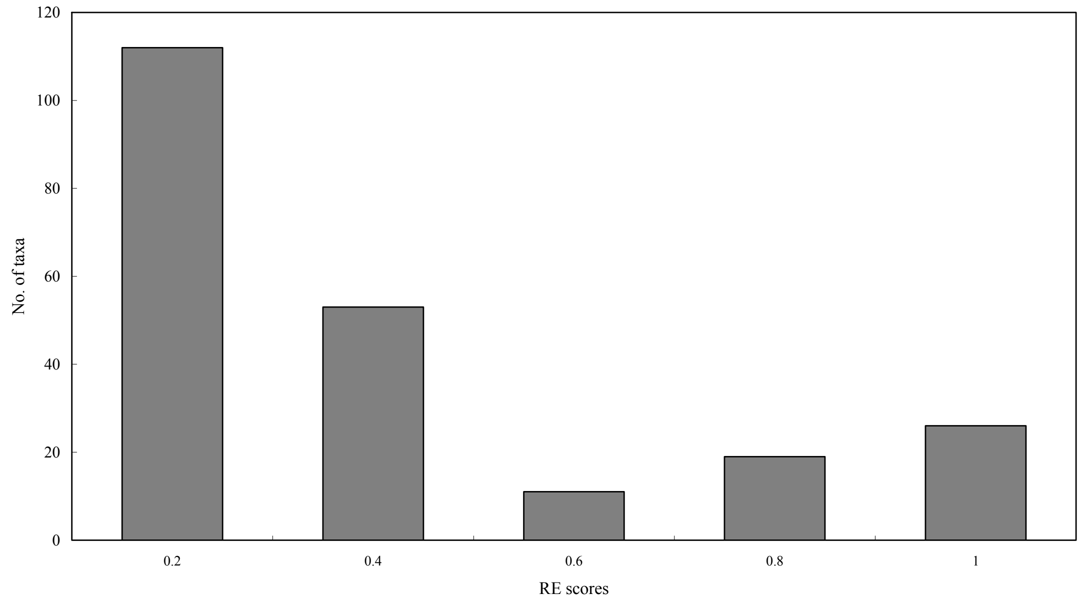
Fig. 1 a-b. The frequency distributions of two component scores: Relative Vulnerability (RV) and Relative Occupancy (RO) for 221 South African terrestrial mammals.



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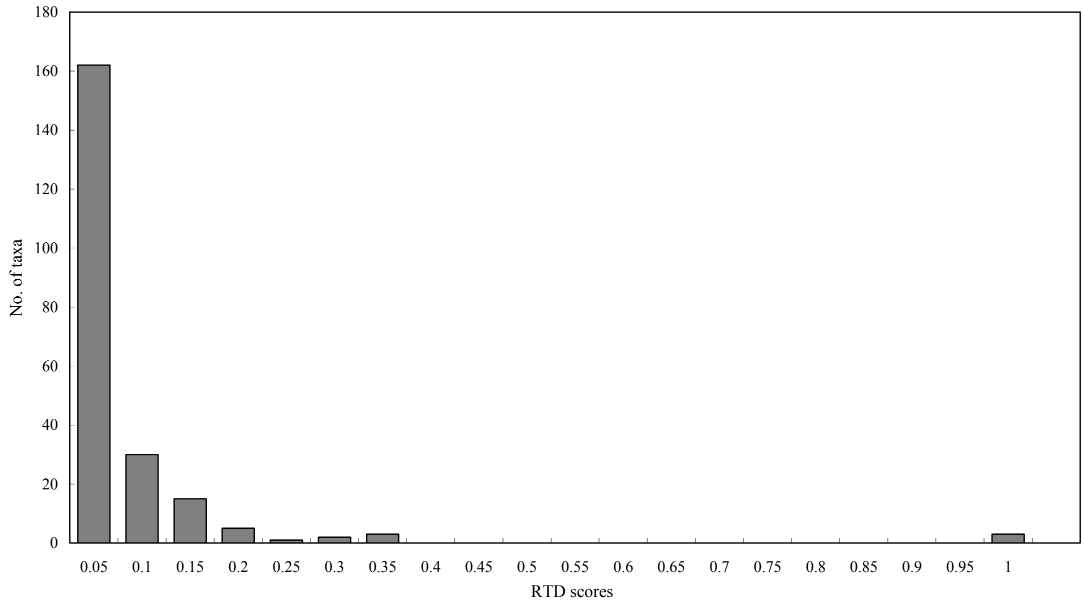

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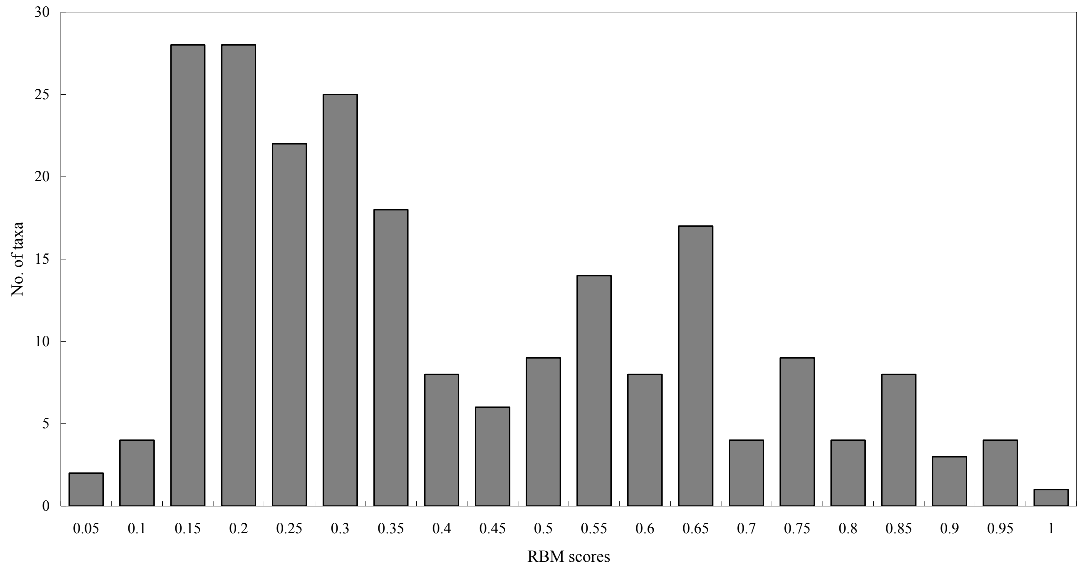
Fig. 1 c-d. The frequency distributions of two component scores: Relative Endemism (RE), and Relative Taxonomic Distinctiveness (RTD), for 221 South African terrestrial mammals.



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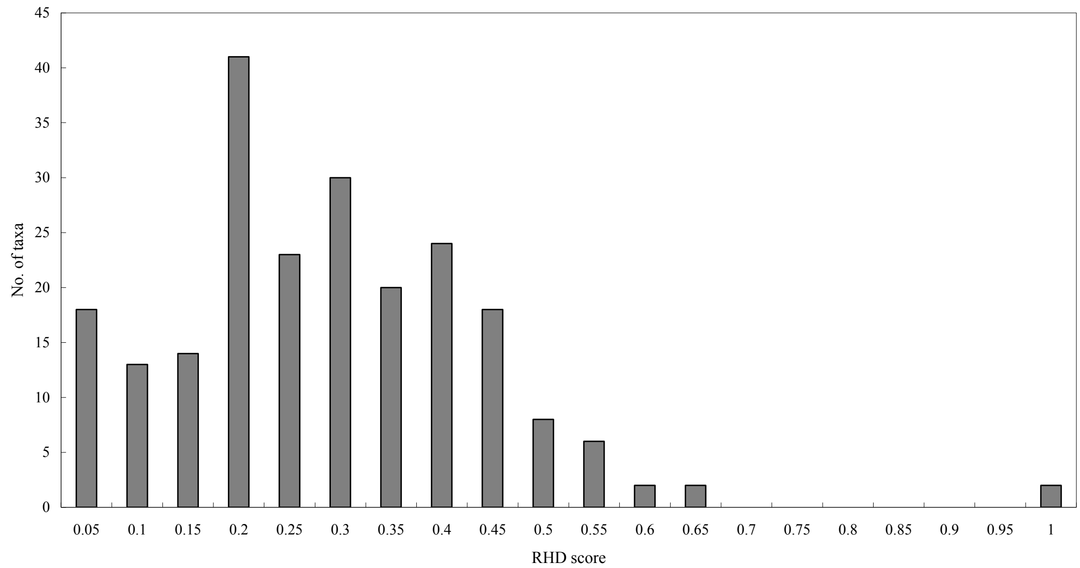

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Fig. 1 e-f. The frequency distributions of two component scores: Relative Body Mass (RBM) and Relative Human Density (RHD) for 221 South African terrestrial mammals.

RPS components:

All of the RPS components were significantly different from each other (Kruskall Wallis $H_{5,\ 1326}$ = 584.76; $P < 0.001$). Analysis of paired RPS components indicated significant correlations among most pairs (Table 1). The strongest significant correlations among paired components were found between RTD and RBM as well as between RO and RV. The strongest significant negative correlation was between RO and RBM. Similar to Freitag and van Jaarsveld (1997), the RPS components were positively skewed suggesting that priority taxa are easily identified at the regional level when using the different RPS components (Fig. 1a – f).

Five of the paired components were not significantly correlated (Table 1). These included the correlations between RTD and vulnerability (RV), as well as between RTD and RHD. Relative endemism (RE), RV and RO, well as RHD and RBM were not significantly correlated. The weak significant negative correlation between RHD and RE contradicts the findings of Balmford et al. (2001) obtained at a continental scale, which showed that in densely human populated areas (i.e., areas with high RHDs), the majority of taxa were geographically restricted (i.e., with high RE). Because the current study was only limited to South Africa and a species-level rather than including sub-species-level analyses, the delineated pattern may be locally dominated by the more widespread taxa (Freitag & van Jaarsveld 1995; Lennon et al. 2004).

A statistically significant positive correlation has also been shown to exist between human population density and mammal (Balmford *et al.* 2001) and bird species richness (Chown *et al.*, 2003), both at a continental and South African scale. Reed (1990) cautions about the inherent absence or weak relationships that may exist between selected life history, extinction, and rarity variables, which usually feature as components in setting conservation priority exercises. In kind Chown et al. (2003) comments "[that] it is not clear why the relationship between bird species richness and human population density has persisted" (see Chown et al 2003 for further discussion). In addition, a possible explanation for the differences in the results between the current and the previously cited studies may be attributed to the lack of spatially explicit measures, as well as differences in scale (spatial and temporal) and/or taxa used (Freitag & van Jaarsveld 1995; Lombard 1995).

RV scores indicated 127 species to have RV values of 0.00 (i.e., Least Concern (LC)) (Fig. 1a), while 33 species were included in the threatened categories (i.e., Critically Endangered, Endangered or Vulnerable). The majority of threatened taxa scoring high RV scores were grouped in the orders

Insectivora and Chiroptera (Mugo et al. 1995; Friedmann & Daly 2004). The integration of regional Red List assessments (Friedmann & Daly 2004) into the current study incorporates not only the most up-to-date regional extinction risk data but also the more quantitative method for Red List assessment, as was suggested by Freitag & van Jaarsveld (1997). On the other hand, RO scores ranged from 0.008 to 0.28 (Fig. 1b), with van Zyl's golden mole (*Cryptochloris zyli*), known from only one locality in the Northern Cape Province (Skinner & Smithers 1990) having the highest RO value. Freitag & van Jaarsveld (1997) encountered similar small RO values for most taxa with few of the more range-restricted taxa attaining larger RO values. This is could be related to the limited distributional data for most mammals in South Africa (Freitag & van Jaarsveld 1995).

RTD scores ranged from 0.007 to 1.00, with a median value of 0.029 (Fig. 1c), a considerably lower median value compared with the other RPS components. Three monotypic species, the African elephant (*Loxodonta africana*), aardvark (*Orycteropus afer*), and the pangolin (*Manis temminckii*) scored RTD values of 1, while rodents and the chiropteran had relatively low RTD scores (also see Freitag & van Jaarsveld 1997). RE values for most species were around 0.20, indicating that 0 - 24% of their distributional range occurs in South Africa (Fig. 1d). Twenty-six of these were classified as endemic (i.e., RE = 1), with a large proportion of them being threatened by extinction (see Chapter 1) and are consequently, of great conservation concern within a national conservation framework (Danell & Aava-Olsson 2002).

The RBM component (Fig. 1e) resulted in a more even distribution of log mass categories (0.01-1.00). Similar to the findings of Entwistle and Stephenson (2000), most species were found to weigh less than 7 kg, as a large proportion (61%) of South African mammals are rodents, bats, and insectivores. The human density component (RHD) had a median of 0.25 (Fig. 1f) with values ranging from 0.005 to 1.00. Various species such as the large-eared free-tailed bat (*Otomops martiensseni*), the peak-saddle horseshoe bat (*Rhinolophus blasii*), and the Damara woolly bat, (*Kerivoula argentata*) had high RHD values and this could be attributed to their distributions being mainly restricted to large metropolitan areas and some coastal regions (Western Cape, Eastern Cape and Eastern KwaZulu-Natal Provinces). Although some bats are considered to be expanding their distributional ranges by exploiting artificial roosting sites (such as house roofs, under bridges, and abandoned mines), they are also inherently subjected to eradication through increased human interaction and pest control measures (Gelderblom et al. 1995).

Although having usually low RTD values, smaller mammals generally exhibit higher levels of endemism and vulnerability values. The top-ranked species with reference to human density are also generally represented by the smaller mammals. It therefore, appears that when considering most of the priority setting components (except for RTD and RBM), smaller species are generally ranked higher in terms of conservation priorities in South Africa. This view is supported by the negative relationship between body mass and the other priority setting variables assessed in the present study.

Regional Priorities Scores

Although the values of the two RPS techniques (RPS_{01} and RPS_{02}) used in the present investigation were strongly correlated with each other (Spearman $R = 0.79$; d.f. = 220; $P < 0.05$), there were marked differences in individual RPS scores. The majority (> 83.74%) of the 221 taxa had RPS_{01} and RPS_{02} scores of less than 0.30 (Fig. 2). Based on RPS_{01}, 33 species (25.33%) were placed within the 0.10 - 0.14 RPS score category. In contrast, the majority of taxa (26.69%) were placed in the 0.21 – 0.25 RPS score category by the RPS_{02} technique (Fig. 2).

From the species that were identified as of conservation importance in South Africa by each of the two RPS techniques, the top 22 species (top 10%) indicated the effect of the various RPS components and their influence on the composite regional priority scoring. Apart from a few members of the Carnivora and Chiroptera, the Order Insectivora dominated (63.63%) the top 22 RPS_{01}-ranked taxa (Table 2; Fig. 3). When body mass (RBM) was incorporated into the RPS assessment, a number of larger/heavier taxa were included in the top 22 species that were identified to be of high conservation priority in South Africa (e.g. African elephant, *Loxodonta africana*). The subsequent incorporation of relative human density (RHD) into the RPS assessment included additional taxa that were not shown to be of high conservation priority in South Africa by the RPS_{01} technique. Van Zyl's golden mole (*Cryptochloris zyli*) scored the highest RPS_{01} score (0.58) and was ranked ninth by the RPS_{02} technique (Table 2). The incorporation of relative human density (RHD) and relative body mass (RBM) in the RPS_{02} technique placed Juliana's golden mole (*Neamblysomus julianae*) at the top of the conservation priority list for South Africa.

Only the RPS_{02} technique identified some carnivores as conservation priority taxa, listing the wild dog (*Lycaon pictus*) and the brown hyaena (*Hyaena brunnea*) as of high conservation priority in South Africa. Mills et al. (2001) identified the wild dog as the second highest conservation priority species in Africa, while the brown hyena was ranked sixth. Ginsberg (2001) noted that priority-setting exercises

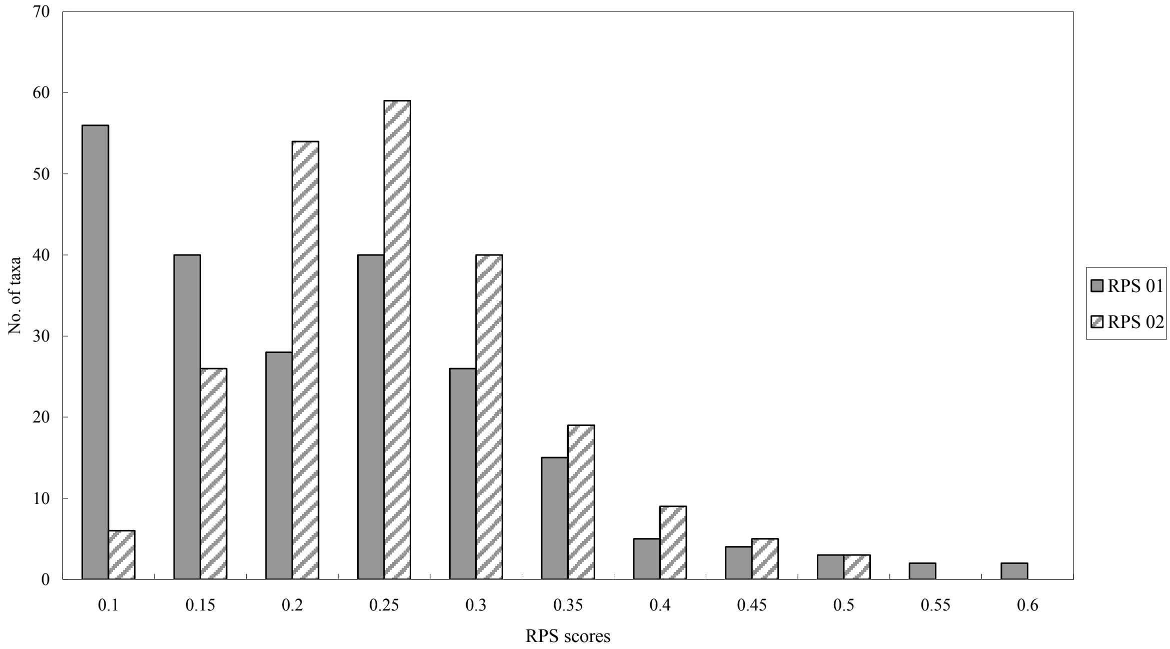

Fig. 2. Regional Priority Scores (RPS) distributions for the two RPS techniques RPS_{01} (Freitag & van Jaarsveld 1997) and RPS_{02} for the South African terrestrial mammals.

Table 2. Regional Priority Score rankings of the top 22 priority taxa (top 10%) based on the two RPS techniques (RPS_{01} (Freitag & van Jaarsveld 1997), and RPS_{02}) (highlighted in bold), as well as the IUCN Red List assessed taxa (Friedmann & Daly 2004) not identified to be in the top 22 RPS priority list. * = 13 species which were consistently identified, by all three RPS techniques, as priority species). V* =corrected coefficient of variation values calculated for the RPS scores. Bold ranks of $Rank_{01}$ and $Rank_{02}$ indicate the top 22 taxa for each RPS technique.

Order	Taxon name	IUCN Red List	RPS_{01}	$Rank_{01}$	RPS_{02}	$Rank_{02}$	V*
Chiroptera	***Cloeotis percivali****	CR A2, a	0.38	**13**	0.33	**20**	33.75
Insectivora	***Cryptochloris wintoni****	CR B1ab(iii), B2ab(iii), D	0.56	**2**	0.38	**11**	110.15
Insectivora	***Cryptochloris zyli****	CR B1ab(iii)+2ab(iii); D	0.58	**1**	0.39	**9**	127.28
Insectivora	***Chrysospalax villosus****	CR C2a(i), D	0.51	**4**	0.48	**2**	53.03
Lagomorpha	***Bunolagus monticularis****	CR C2a(i), E	0.54	**3**	0.44	**5**	39.77
Rodentia	***Mystromys albicaudatus****	EN A3c	0.41	**10**	0.37	**13**	20.75
Chiroptera	*Kerivoula argentata*	EN B1ab (iii) & 2ab (iii)	0.26	42	0.30	34	16.75
Insectivora	***Neamblysomus gunningi****	EN B1ab(i-iv) B2ab(i-iv)	0.47	**6**	0.45	**4**	31.82
Insectivora	***Myosorex sclateri****	EN B1b(ii,iii), c(iv)+2b(ii,iii), c(iv)	0.47	**7**	0.41	**7**	0
Chiroptera	*Rhinolophus swinnyi*	EN C2a (i)	0.26	50	0.28	60	14.46
Artiodactyla	***Ourebia ourebi***	EN C2a(ii)	0.26	47	0.37	**14**	86.07
Macroscelidae	*Petrodromus tetradactylus*	EN D	0.29	32	0.29	50	34.92
Carnivora	***Lycaon pictus***	EN D	0.27	37	0.33	**21**	43.89
Primates	*Cercopithecus mitis*	VU B1ab (ii,iii,iv)	0.25	59	0.32	23	69.85
Artiodactyla	*Neotragus moschatus zuluensis*	VU B1ab (ii,iii,iv,v)	0.24	65	0.29	47	25.57
Insectivora	*Calcochloris obtusirostris*	VU B1ab(ii,iii),B2ab(ii,iii)	0.25	58	0.22	112	50.54
Hyracoidea	***Dendrohyrax arboreus arboreus***	VU B1ab(iii) + 2ab(iii), C1	0.31	26	0.39	**10**	70.71

Order	Taxon name	IUCN Red List	RPS_{01}	$Rank_{01}$	RPS_{02}	$Rank_{02}$	V*
Insectivora	***Neamblysomus julianae****	VU B2 ab (ii,iii)	0.44	**8**	0.5	**1**	123.74
Insectivora	***Chrysospalax trevelyani****	VU B2 ab (ii,iii, iv)	0.44	**9**	0.43	**6**	31.82
Insectivora	***Crocidura maquassiensis****	VU B2a,c(ii,iv)	0.33	**20**	0.34	**18**	8.37
Insectivora	***Eremitalpa granti***	VU B2ab (ii,iii,iv)	0.34	**19**	0.27	66	87.97
Rodentia	*Cricetomys gambianus*	VU C1	0.24	69	0.30	43	36.93
Pholidota	***Manis temminckii****	VU C1	0.48	**5**	0.45	**3**	39.77
Artiodactyla	*Hippotragus niger niger*	VU C1 + 2a(i)	0.23	74	0.36	**15**	105.47
Artiodactyla	*Philantomba monticola*	VU C1, C2a(i)	0.23	70	0.32	25	75.36
Carnivora	*Acinonyx jubatus*	VU D1	0.24	66	0.31	30	59.66
Carnivora	*Panthera leo*	VU D1	0.24	68	0.32	24	76.09
Artiodactyla	*Hippotragus equinus*	VU D1	0.23	73	0.32	27	73.19
Chiroptera	*Laephotis wintoni*	VU D2	0.29	33	0.26	73	60.04
Chiroptera	***Otomops martiensseni***	VU D2	0.25	53	0.38	**12**	100.35
Chiroptera	*Laephotis botswanae*	VU D2	0.24	67	0.20	138	55.10
Chiroptera	*Cistugo seabrai*	VU D2	0.23	71	0.18	157	60.01
Chiroptera	*Rhinolophus blasii*	VU D2	0.23	75	0.27	63	13.83
Rodentia	***Bathyergus janetta***	NT	0.36	**16**	0.31	31	50.78
Insectivora	***Myosorex longicaudatus***	NT	0.4	**11**	0.31	32	77.7
Chiroptera	***Rhinolophus capensis***	NT	0.39	**12**	0.32	29	65.97
Chiroptera	***Miniopterus fraterculus***	NT	0.35	**17**	0.32	26	33.3
Chiroptera	***Cistugo lesueuri***	NT	0.35	**18**	0.27	67	91.72
Carnivora	***Hyaena brunnea***	NT	0.27	38	0.33	**19**	53.03
Insectivora	***Chrysochloris asiatica***	DD	0.36	**14**	0.29	46	84.85

Order	**Taxon name**	**IUCN Red List**	**RPS_{01}**	**$Rank_{01}$**	**RPS_{02}**	**$Rank_{02}$**	**V***
Insectivora	***Amblysomus hottentotus****	DD	0.36	**15**	0.35	**17**	9.94
Insectivora	***Chlorotalpa sclateri***	DD	0.32	**21**	0.27	65	81.4
Insectivora	***Suncus lixus***	DD	0.31	**22**	0.31	33	31.82
Insectivora	***Myosorex cafer****	DD	0.31	25	0.33	**22**	10.16
Tubulidentata	***Orycteropus afer***	LC	0.3	31	0.35	**16**	50.78
Proboscidea	***Loxodonta africana***	LC	0.3	30	0.4	**8**	92.11

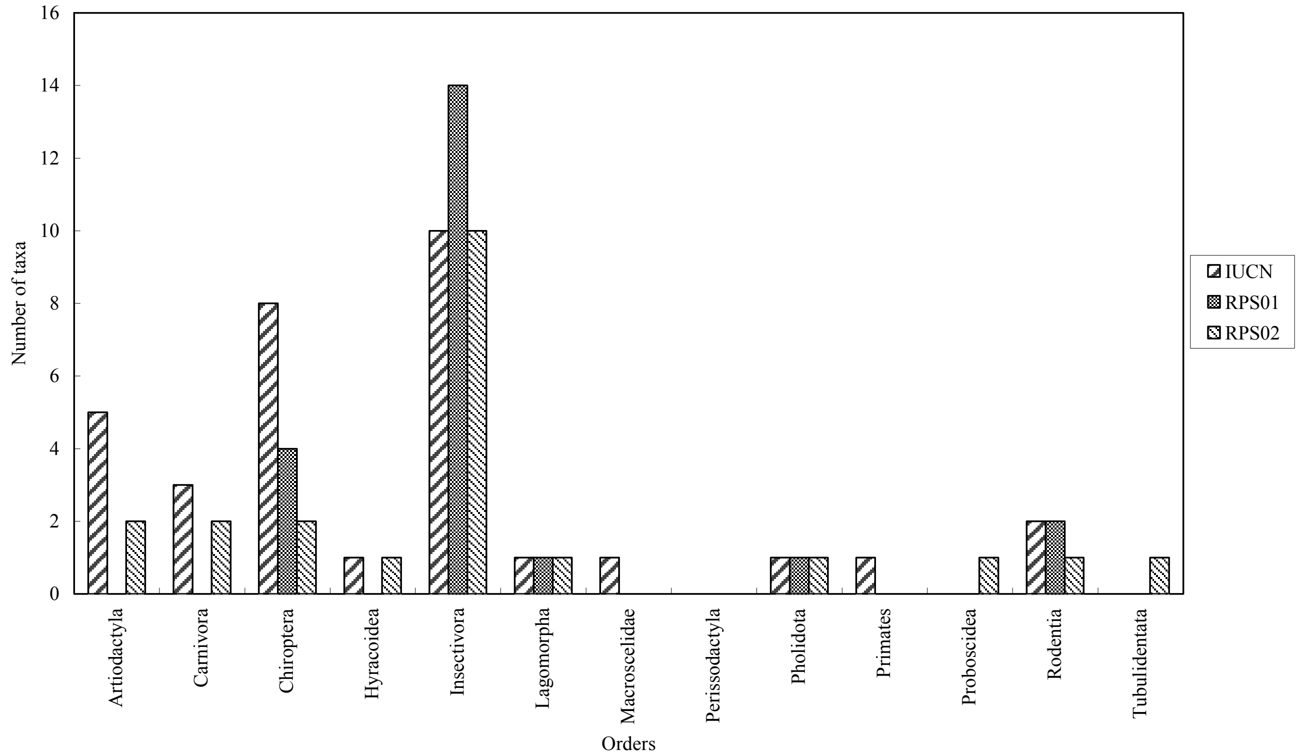

Fig. 3. Rankings per Order of the 33 threatened IUCN Red List species included in the current study (Friedmann & Daly 2004), as well as the top 22 South African terrestrial mammal species based of two RPS techniques (RPS$_{01}$ (Freitag & van Jaarsveld 1997), and RPS$_{02}$).

rarely assign carnivores the conservation priorities they deserve. In the present study, the cheetah (*Acinonyx jubatus*) (VU D1) was ranked 66th by RPS_{01} technique and in the 30th position by the RPS_{02} technique. It is possible that since the majority of the larger carnivores mainly occur in protected areas as well as the northern parts/borders of South Africa (Gelderblom et al. 1995) may result in low RHD, RE, RO, and RTD scores, therefore, leading to lower overall regional conservation priority rankings.

The IUCN Red List identified 57 South African marine and terrestrial mammals as threatened or at the risk of extinction in the near future (Friedmann & Daly 2004), of which 33 were included in the present study. Similar to the IUCN threat categories, the top 22 priority species identified by the two RPS techniques in the present study mostly comprised insectivores. All Critically Endangered (CR) and some of the Endangered (EN) and Vulnerable (VU) species identified within South Africa by the IUCN Red List (Friedman & Daly 2004) were among the top 22 species identified by the two RPS techniques. Species ranked as Vulnerable (VU) by the IUCN Red List (Friedman & Daly 2004) were not always identified by the two RPS techniques used in the present investigation (Tables 2).

Various Data Deficient (DD) and Near Threatened (NT) mammals were included in priority lists based on the RPS techniques used in the present study. Of particular relevance is that the RPS_{02} technique identified two non-top 22 RPS_{01} as well as Least Concern (LC) mammals, the African elephant (*Loxodonta africana*), and aardvark (*Orycteropus afer*) to be of high priority. It is possible that the listing of these two taxa may be attributed to their scoring relative high RBM and RTD values.

Using the two RPS techniques, this study detected considerable variation in RPS scores and rankings obtained for South African mammals. The *among*-technique RPS coefficients of variation (CV) for the top 22 species ranged between 0.00 and 105.7% (Table 2), with only three of the species that occur in both the top 22 lists, yielding CVs of less than 10%. This may indicate that priority-setting techniques are highly dependant on the components considered in the analysis, and how these components are scored, weighted, and integrated (Mehlman et al. 2004; Keith et al. 2005).

Of significance in this study, however, is that 13 species were consistently placed among the top 22 species identified to be of conservation priority in South Africa by both the RPS_{01} and RPS_{02} techniques (Table 2). Twelve of these 13 species were also categorised as threatened by the IUCN Red List (Friedmann & Daly 2004), with the Hottentot's golden mole (*Amblysomus hottentotus*) being assessed as Data Deficient (DD) (Table 2). However, these taxa are not deemed to be of high conservation priority based merely on the high extinction risk assessment contribution by the regional IUCN Red List. Their RPS rankings are further strengthened by additional irreplaceability and threat components included in the current priority setting exercise. For example, despite a low RV value and being Data Deficient (DD), the Hottentot's golden mole (*A. hottentotus*) still scored high in both RPS_{01} and RPS_{02} listings being an endemic taxon with a relatively high RHD score.

Conclusion

Yu and Dobson (2000) demonstrated that many mammalian species exhibit a strong tendency towards rarity. Rarity varies both in space and time, regardless of whether they are in a pristine or an altered ecosystem (Ferrar, 1991; Gaston, 1994). Since the identification of conservation priorities for species at risk of extinction is usually determined by rarity and vulnerability, the question arises as to how to incorporate irreplaceability and threat variables, and how these should be used to develop a sound methodology for species conservation prioritisation (Ferrar 1991; Pressey et al. 1993; Gaston 1994; Gaston and Blackburn 1997; Reed 1999).

We do not presume that the RPS components used in the current study are necessarily optimal. However, unlike the IUCN Red List assessment for example, the RPS technique as used here incorporates various other measures and not only those solely related to the risk of extinction. These other measures also include those that are related to conservation value (i.e., measures of irreplaceability such as endemism and taxonomic distinctiveness) as well as measures of threat. This approach, therefore, attempts to quantify the vulnerability, uniqueness, and importance of a taxon to qualify for conservation action within a specific area such as South Africa (Vane Wright et al. 1991; Pressey et al. 1993). Although it was not always possible to include explicit measures of regional threat specific to a taxon, the use of body mass and human densities as surrogates measures for threat in the present study high-lights their importance in determining conservation prioritisation outcomes.

Red List categories reflect the extinction risk of a taxon and not the actual priority for conservation (Gärdenfors et al. 1999; Ginsberg 1999; Harcourt& Parks 2003). Despite published Red Lists being available for taxa, these do not constitute a conservation priority-setting tool (Ginsberg 1999; 2001; Tobias & Seddon 2002). Given the clear need for a regional conservation priority-setting tool for South African species, any of the RPS techniques may offer a useful conservation priority assessment tool that can easily be applied in many areas of the world using a minimum of available data. Nevertheless, the Red List is probably the most widely used assessment method for identifying species at risk of extinction. It offers an invaluable source of information and acts as a baseline for taxa that require immediate attention for conservation priority. The Red List is also particularly useful in the absence of alternative, more encompassing species conservation priority-setting strategies.

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